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INFORMAL REPORT

"SURVEYMARINE" A HIGH SPEED HYDROGRAPHIC SURVEY PLATFORM

FEBRUARY 1969

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NAVAL OCEANOGRAPHIC OFFICE
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INFORMAL REPORT

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ABSTRACT

Development of the HYDRA Survey System family of lightweight automated hydrographic data acquisition systems by the U. S. Naval Oceanographic Office (NAVOCEANO) has in turn generated a new requirement for an advanced family of survey platforms. To take full advantage of HYDRA's high density recording capabilities, an effective stable platform suitable for housing such equipment and operating at speeds in excess of 40 knots is essential. Those platforms showing the most promise are hydrofoils and sidewall hovercraft.

NAVOCEANO has participated in several demonstrations of commercially available hovercraft and hydrofoils in addition to conducting a series of trials of its own. To date sidewall hovercraft have shown more potential as survey platforms owing to their greater range of efficient operating speeds.

The intent of this report is to discuss the unique characteristics of a 51-foot sidewall hovercraft recently tested off the English Coast. This particular craft was completely fitted out with automated hydrographic data acquisition and survey control instrumentation.

This report has been reviewed and is approved for release as an UNCLASSIFIED Informal Report.

JOHN N. SPINNING
DAN G. DIXON

Charting Techniques Branch
Hydrographic Development Division
Research and Development Department

APPROVED FOR RELEASE: C. A. Crandall
Director
Hydrographic Development Division

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INTRODUCTION

The Research and Development Department of the U. S. Naval Oceanographic Office (NAVOCEANO) recently developed the HYDRA Survey System family of lightweight portable digital data acquisition systems. This significant contribution towards totally automating hydrographic surveying has in turn generated a requirement for an advanced survey platform capable of housing such equipment and operating at speeds in excess of 40 knots.

Stable high-speed platforms are few in number and highly experimental. Hydrofoils and sidewall hovercraft show the most promise. Trials to date indicate that the latter have greater potential as survey platforms due to their wider range of efficient operating speeds.

A series of high speed sea trials conducted aboard a 51-foot side-wall hovercraft, off the English Coast, conclusively demonstrated the feasibility of surveying from such a platform employing the HYDRA Survey System concept.

The intent of this Informal Report is to describe the unique design characteristics of the sidewall hovercraft used for these trials, and to discuss the on board instrumentation package.

GENERAL DESCRIPTION

1. Craft Description and Specifications

Hovercraft in general are high speed stable platforms designed for operation in rivers, harbors, and nearshore environs. Conservative draft requirements make them an ideal selection for operations in areas subject to large tidal fluctuations which often constitute hazardous conditions for conventional craft.

The basic hull of the craft described in this report is constructed of molded fiberglass (see Figure 1). Standard marine engines and associated hardware are utilized throughout, thereby reducing maintenance and replacement problems. The craft has two side keels (sidewalls) which extend below the base of the main hull. These sidewalls provide a keel effect that furnishes a positive directional control for maneuvering. They also provide substantial roll stability similar to that of a catamaran. In conjunction with the sidewalls two flexible rubber skirts, at the fore and aft extremes, form a seal for the air cushion.

Power for both the air cushion lift and drive systems is supplied by Cummins diesel engines. Other diesel power units, gasoline, or gas turbine engines, however, could be utilized to accomodate special operational

FIGURE 1. 51-FOOT HOVERCRAFT "SURVEYMARINE" ON AIR CUSHION

requirements. Two conventional marine propellers are mounted in the sidewalls; protected from surface debris by skegs. Maximum operating speeds for this craft range from 40 knots in calm seas down to 25 knots in state three (3) seas.

Hull, decks, and superstructure are all constructed of fiberglass (see Figures 2 and 3). This material has proved highly resilient and effective in absorbing wear encountered in normal usage. Both sidewalls are foam-filled giving the craft substantial reserves of buoyancy. In the unlikely event of air cushion lift engine failure, the craft settles down in the water and continues to function at reduced speed as a traditional displacement craft. Specifications of the craft are as follows:

PRINCIPAL SPECIFICATIONS

Length (overall)	51 ft.
Beam	20 ft.
Height (hovering above water line)	13 ft.
Draft (off air cushion)	3 ft. 6 ins.
Draft (hovering)	1 ft.
Craft (fully loaded)	16 tons
Normal disposable load	5 tons
Cruise speed (max.)	40 knots
Normal operating range	200 n.m.
Lift engine (diesel)	186 BHP
Propulsion engine (diesel-2)	320 BHP

A. Features for Hydrographic Survey Applications

The sidewall hovercraft used for the sea trials was one of the builder's standard passenger craft configurations. For hydrographic survey work a similar craft is offered differing only in superstructure layout (see Figure 4). In the survey version the main cabin measures 14 feet in length and has a 12-foot beam. This cabin houses all the digital data acquisitioning and survey control instrumentation, while providing ample space for operating personnel. The propulsion engine spaces are located abaft the survey cabin and are fully sound insulated. Flush fitting hatches over the engine spaces insure ready access without sacrificing usable deck space. The after deck area measures 10 feet by 19 feet 6 inches providing adequate space for carrying additional survey gear and sensors (see Figure 5). The lift air cushion engine is situated in a compartment below the foredeck. This 186 BHP diesel supplies direct drive power to four (4) of the five (5) lift fans. It also transmits hydraulic power to the after-lift fan unit. Additional galley space, berthing, supplemental fuel compartments, washrooms, and toilet facilities may be incorporated into the craft depending upon user needs.

FIGURE 3. STERN VIEW OF HOVERCRAFT

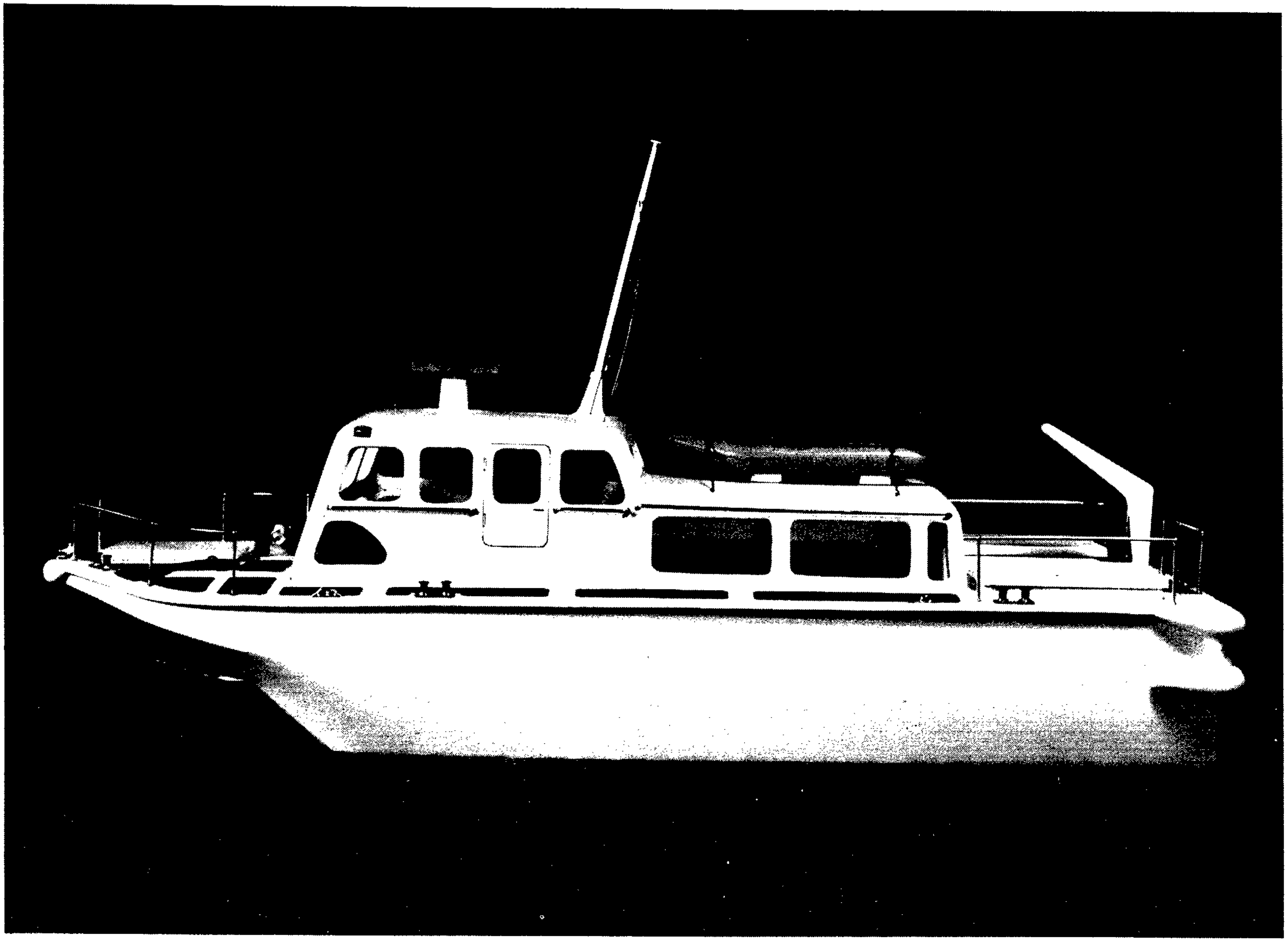

FIGURE 4. MODEL OF HOVERCRAFT DESIGNED SPECIFICALLY FOR HYDROGRAPHIC SURVEY APPLICATIONS

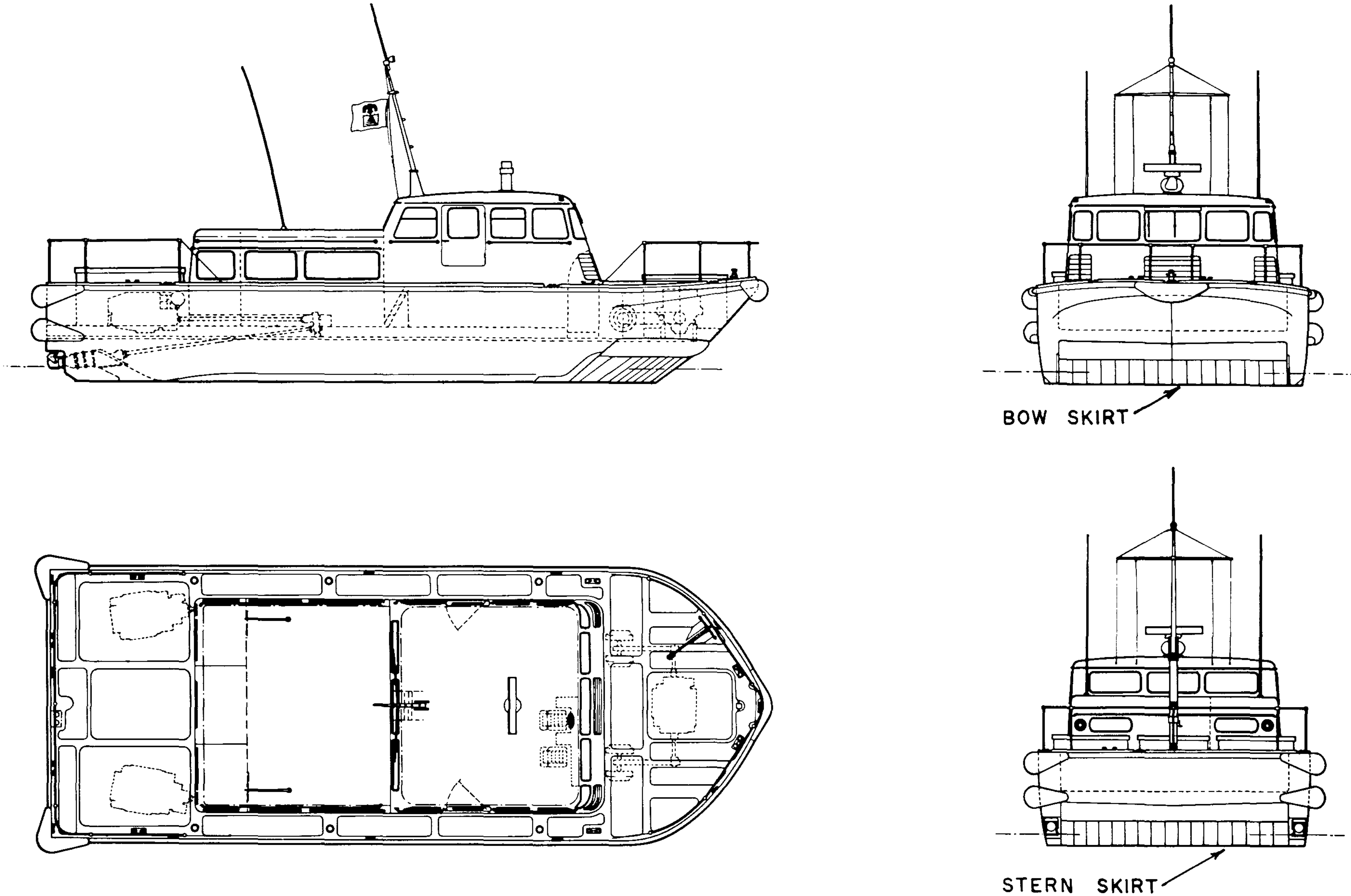

FIGURE 5. DIAGRAMMATIC VIEWS OF SURVEY HOVERCRAFT ILLUSTRATING DEPLOYMENT OF PROPULSION AND LIFT SYSTEMS

2. Components and Functions of Automated Survey Instrumentation

The 51-foot hovercraft tested was built by Hovermarine Limited of Southampton, England. All survey instrumentation aboard was installed by the Decca Navigator Company of London. The craft was named "SURVEYMARINE" and represented what both firms hoped would be a mutually beneficial undertaking. "SURVEYMARINE" (see Figure 6) was equipped with an automated digital data acquisition system similar to that developed by NAVOCEANO's Research and Development Department. Survey data, consisting of positions and depths correlated with time, were recorded at speeds during the trials in excess of 34 knots aboard the craft. The basic difference between NAVOCEANO's HYDRA Survey System and the "SURVEYMARINE" version involves the method by which digitized data is stored and recorded. The English version utilizes a punched paper tape unit being fed properly sequenced information from a Data Logger, whereas NAVOCEANO's HYDRA Survey System employs a magnetic tape recorder and digital control unit data processor. NAVOCEANO's HYDRA Survey System is capable of recording complete records at a rate approximately 50 times greater than the "SURVEYMARINE" configuration thus giving better resolution.

The system aboard the hovercraft may be considered as performing four separate and distinct functions: position fixing, depth finding, data correlation and recording, and auto-pilot control of the survey craft along predetermined course tracks (see Figure 7).

A. Decca Electronic Positioning

With only minor changes in equipment configuration, Decca Main Chain, Hi-Fix, or Sea-Fix electronic positioning systems may be used to control the survey. As a result of NAVOCEANO's R&D Department's keen interest in Sea-Fix, this system was chosen for the trials. Sea-Fix is a portable, lightweight, one watt electronic positioning system designed primarily for mounting on buoys. Sea-Fix has a predicted service range of 20 to 50 nautical miles over water. Fix accuracies manifest a standard deviation of one (1) meter (3.28 feet) on the baseline. A Decca Sea-Fix receiver resolves electronic coordinate information and displays this data on lane counters mounted on the front of the receiver. These counters furnish survey personnel with position information for visual comparison checks. The Sea-Fix receiver also supplies digitized electronic coordinate values to the various controlling units and for correlation with time and depth information.

B. Depth Finding

The Atlas Digital Depth Finding System, identical to that used in NAVOCEANO's HYDRA Survey System, is used in the English array. This

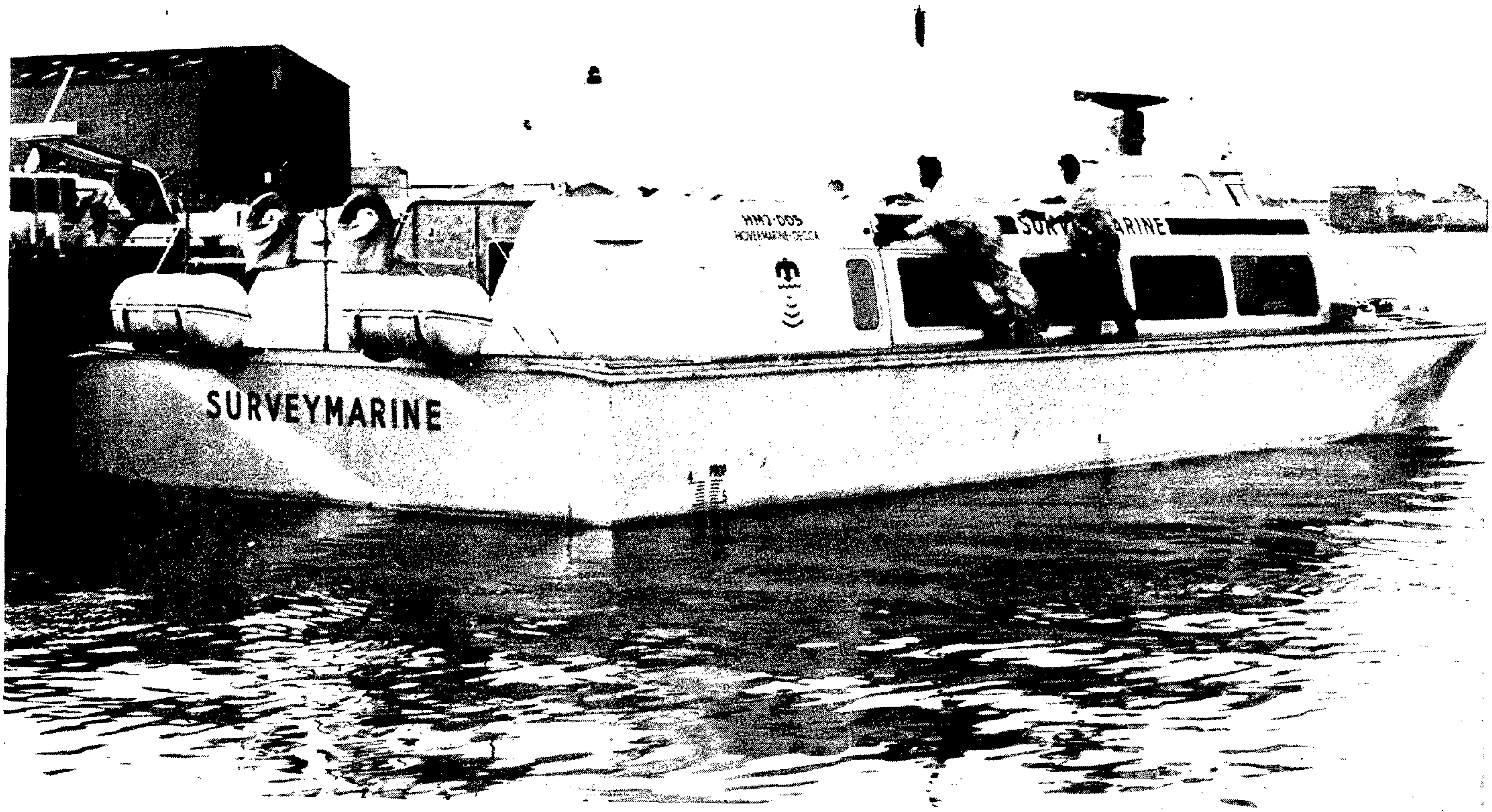

FIGURE 6. HOVERCRAFT "SURVEYMARINE" AT DOCKSIDE

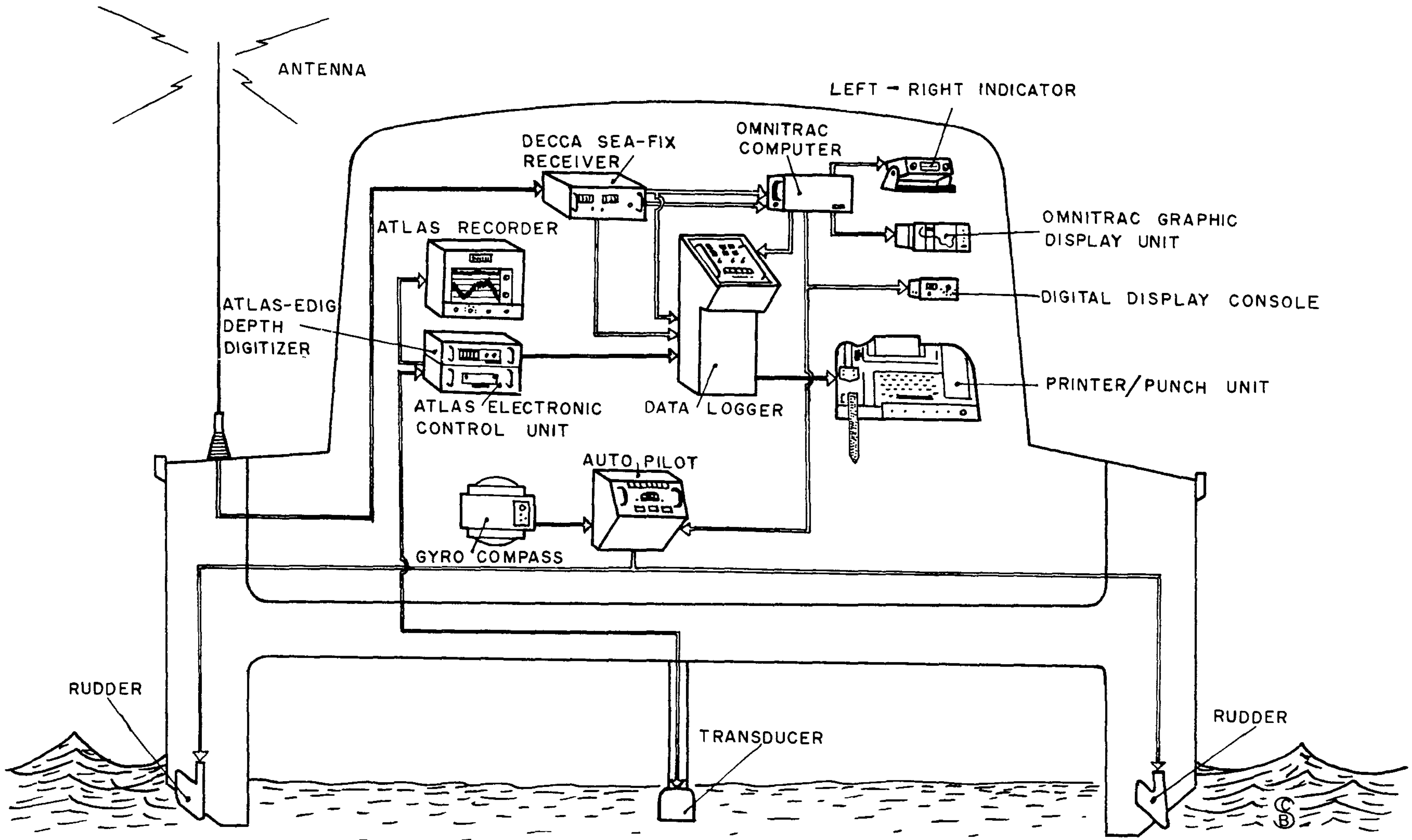

FIGURE 7. HIGH-SPEED SURVEY EQUIPMENT ABOARD HOVERCRAFT "SURVEYMARINE"

system gives reliable and accurate depth determination and digitization at high speeds with an accuracy on the order of 6 inches in 66 feet.

(a) Atlas Echo-Sounder

This sounder contains two basic components, the electronic unit and recording unit. The function of the electronic unit is to convert electrical pulses into sound waves; transmit these sound waves from the Atlas transducers to the river or ocean bottom; receive and convert the resulting echoes back into electrical pulses; and transmit these pulses to the echo-sounder recording unit and depth digitizer. The circuitry in the electronic unit utilizes solid-state modular techniques including micrologic circuitry. Transmission on two frequencies simultaneously, time dependent volume control, and automatic gain control are only a few of the special features of this unit. The function of the recording unit is to display depths in analog form on paper as they are received from the electronic unit. A unique feature of this unit makes it possible for a visual indication to be given when depth data is being properly digitized and recorded on magnetic or paper punched tape. This indicator appears as a second trace located beneath the depth trace on the analog record.

(b) Atlas Transducers

The Atlas Echo-Sounder is provided with two transducers, one operating at 30 kHz and the other at 210 kHz (see Figure 8). Both transducers are mounted in a teardrop shaped housing which is rigged below the air cushion/water interface. This hydrodynamically designed housing reduces noise normally caused by cavitation, thus permitting high speed operations. The transducer mount, which may be raised or lowered to the desired position manually, is situated in a well amidships along the centerline of the craft. Under normal operating conditions the transducers are lowered to twelve (12) inches below the air cushion/water interface which approximates the corresponding depth of the craft's sidewalls.

(c) Atlas Depth Digitizer

This fully solid-state unit forms the link between depth data acquisition and data recording. The travel time between

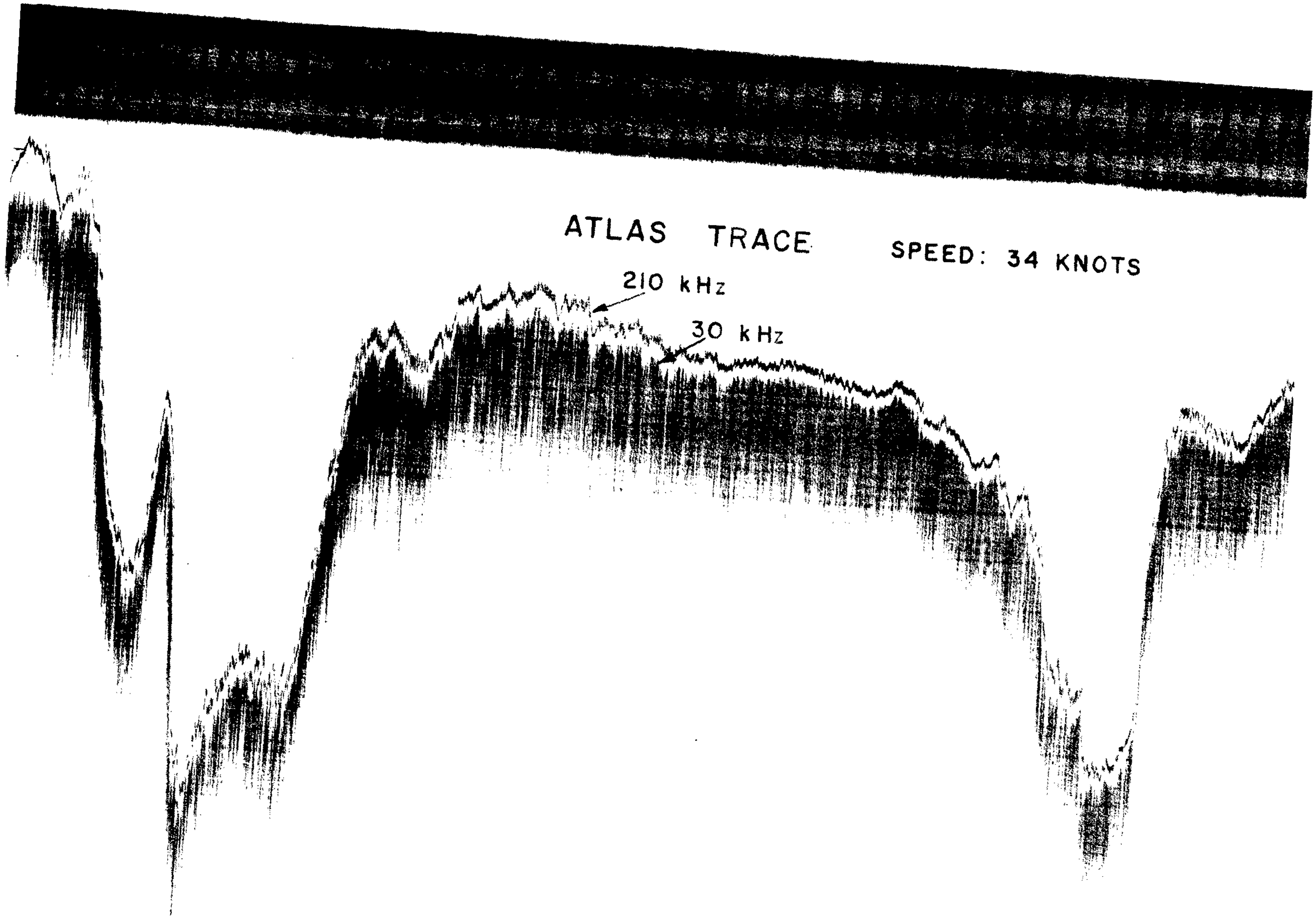

FIGURE 8. ATLAS RECORDER TRACE

transmission pulse and bottom echo, as measured by the echo-sounder, is converted into digital output values. The primary task of the digitizer is to distinguish the first true bottom echo from reverberation noise, ambient noise, or multiple echo. Continuous operation over areas of considerably varying depth, without adjustment of any operating element, is made possible by several unique design features. Digital depth information is also read out on a nixie tube display on the unit.

C. Data Correlation and Recording

(a) Data Logger

Before digitized data from the Sea-Fix receiver and Atlas Echo-Sounder can be recorded on punched tape, it must be properly correlated and sequenced with the correct time of day. This function is performed by a Decca Data Logger. Although the data logger carries out its system assignment well, it and the associated paper printer-punch unit are slow and inadequate for high-density high-speed surveys. It is reasonable to assume that this portion of the "SURVEYMARINE" acquisition system will be replaced by a digital control unit and magnetic tape recorder configuration similar to that developed by NAVOCEANO (see Figure 9).

3. Components and Functions of the Omnitrac Survey Control System

The function of this system is to automatically control the survey craft's movements along predetermined tracks. It is possible through preselection of start/stop points (in X-Y coordinates) of a centerline within the survey area, to automatically determine ten additional parallel equidistant survey passes on either side of this initial line. By means of a switch, the survey craft can automatically be directed to any one of these lines by simply dialing the desired track number.

A. Omnitrac 70 Computer

The Omnitrac 70 Computer processes electronic coordinate information from the Decca Sea-Fix receiver for input to the Omnitrac Graphic Display Unit and accepts information from this unit as necessary to control the automatic track keeping devices (see Figure 10). This computer utilizes a digital concept and is designed to perform only as a navigational tool. Many complex circuits normally found in general purpose computers are thus eliminated. The compactness of this computer is manifested by its 0.23 cubic foot volume and weight of 18 pounds.

FIGURE 9. DECCA AUTOMATED SURVEY INSTRUMENTATION

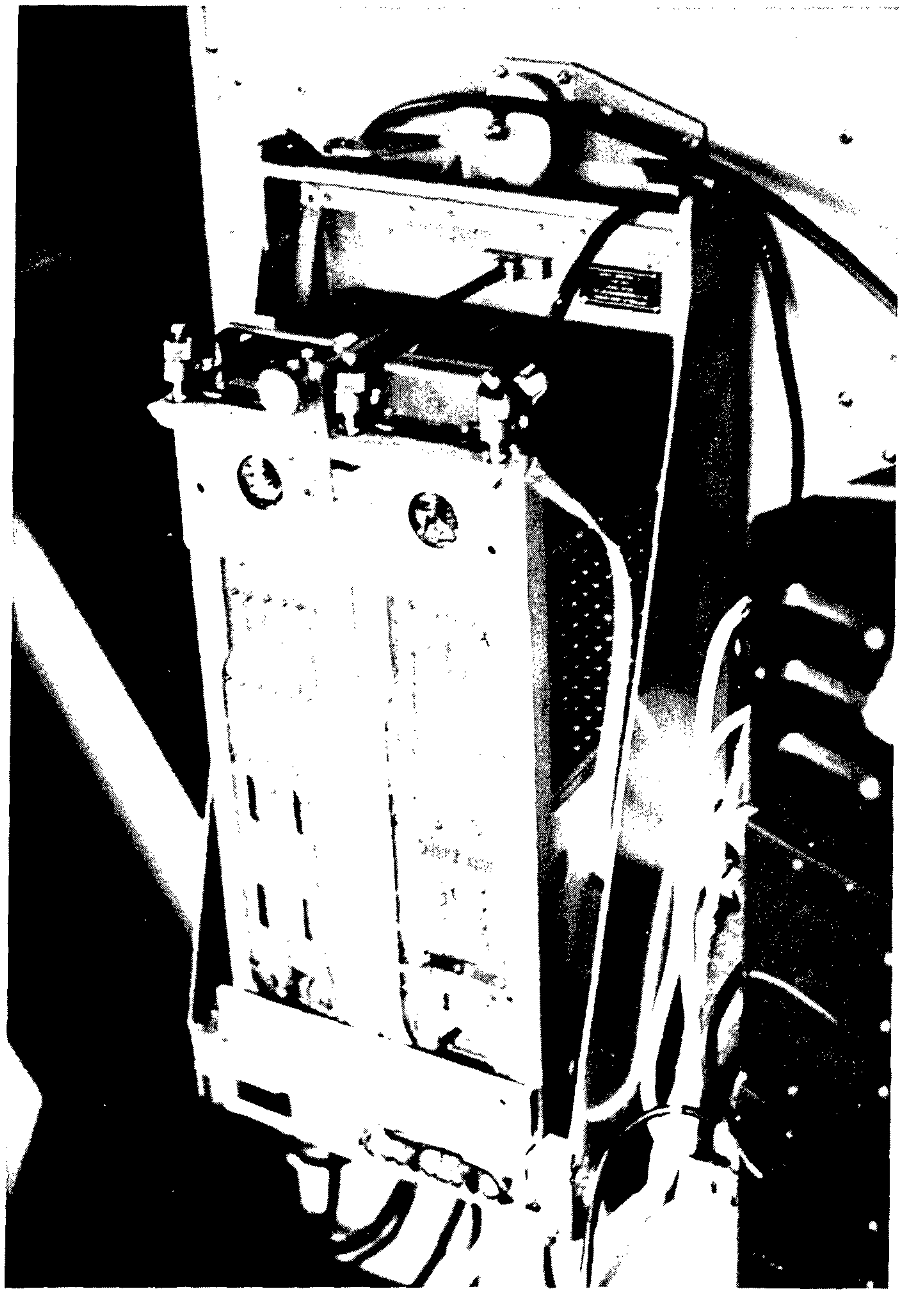

FIGURE 10. OMNITRAC 70 COMPUTER

B. Omnitrac Graphic Display Unit

The prime function of this unit is to continuously inform the survey officer of his present position with reference to a planned survey course. In addition to this operation, the graphic display exhibits a number of other desirable and functional uses. It provides on one continuous roll all required charts, regardless of scale, of the survey area and recalls them appropriately as the survey develops. A continuous track trace is depicted on the chart, which at a glance conveys pertinent navigational data corresponding to the survey plan. This chart also serves as a method of introducing required data into the computer for control of the survey.

A unique feature of the Omnitrac System is a closed loop manipulation of the graphic display in conjunction with the Omnitrac Computer. All necessary information required for survey control can be delineated on the chart and introduced to the control system prior to commencement of the survey. A "tracking bug" representing the survey craft, shows to the survey officer his relative position and movement with respect to surrounding features portrayed on the chart. Any deviation of the bug from the planned track immediately alerts the survey officer. The survey is also automatically monitored by the Omnitrac System with course corrections signified via a left/right indicator in manual steering, and direct auto-pilot rudder angles in automatic steering.

Check points that lie directly on the survey track and other points of navigational significance may be inserted into the computer or replaced, as deemed necessary, through utilization of the Digital Display Console.

A "look ahead feature" incorporated in the graphic display unit permits any other chart on the role to be examined without interfering with the computer processes of continuous position fixing. After employing the "look ahead feature" for review of an alternate chart, the computer will automatically recall the correct chart and pick up its tracking function via the bug.

The graphic display unit is utilized to insert check points and destinations into computer storage and to update or correct information as operational circumstances require. This information may also be inserted into the computer by means of the Digital Display Console.

C. Digital Display Console

The Digital Display Console concurrent with the Omnitrac Graphic Display Unit formulates the survey officer/machine interface for the Omnitrac System. It provides a readout of position in either UTM or geographic coordinates

along with bearing and distance from the present position to any selected check point on the chart by recalling the appropriate output program.

D. Interface Unit

The Interface Unit collects all data from the navigational receiver and Digital Display Console input circuits and feeds the computer as directed by the call up program.

E. Left/Right Indicator Unit

A left/right indicator unit under computer control aids the helmsman in following the survey course track when manual steering is being utilized.

F. Auto-Pilot Unit

The Auto-Pilot controls the degree of rudder angle necessary to maintain a preplanned course by receiving its commands from the Omnitrac Computer.

4. Sea Trials

Sea Trials of "SURVEYMARINE" were conducted in the Solent, a narrow body of water lying between Southampton and the Isle of Wight in Great Britain. A Decca Sea-Fix net was installed along the shore to provide positioning data for navigation and survey control. As the trials were intended primarily to demonstrate hovercraft performance as a survey platform, no special requirement for extensive baselines existed. Thus, minimal baselines approximating seven (7) miles were selected (see Figure 11).

Sea conditions ranged from sea state three (3) to four (4) during the trials being further complicated by strong easterly winds. "SURVEYMARINE" performed extremely well in these seas at speeds in excess of 30 knots, presenting to the passengers (observers) the sensation of traveling over a cobblestone road. On several occasions during the demonstration, the craft was lowered from its air cushion for comparison of its ride characteristics with the performance of a standard displacement craft. This craft again performed well but lacked quick rudder response so readily noted while on the air cushion.

Sounding traces obtained by an Atlas Digital Echo-Sounder on both 30 kHz and 210 kHz at speeds of 34 knots were of outstanding quality. All automatic survey control instrumentation functioned in accordance with plans, providing observers with a truly remarkable demonstration of a totally automated survey operation.

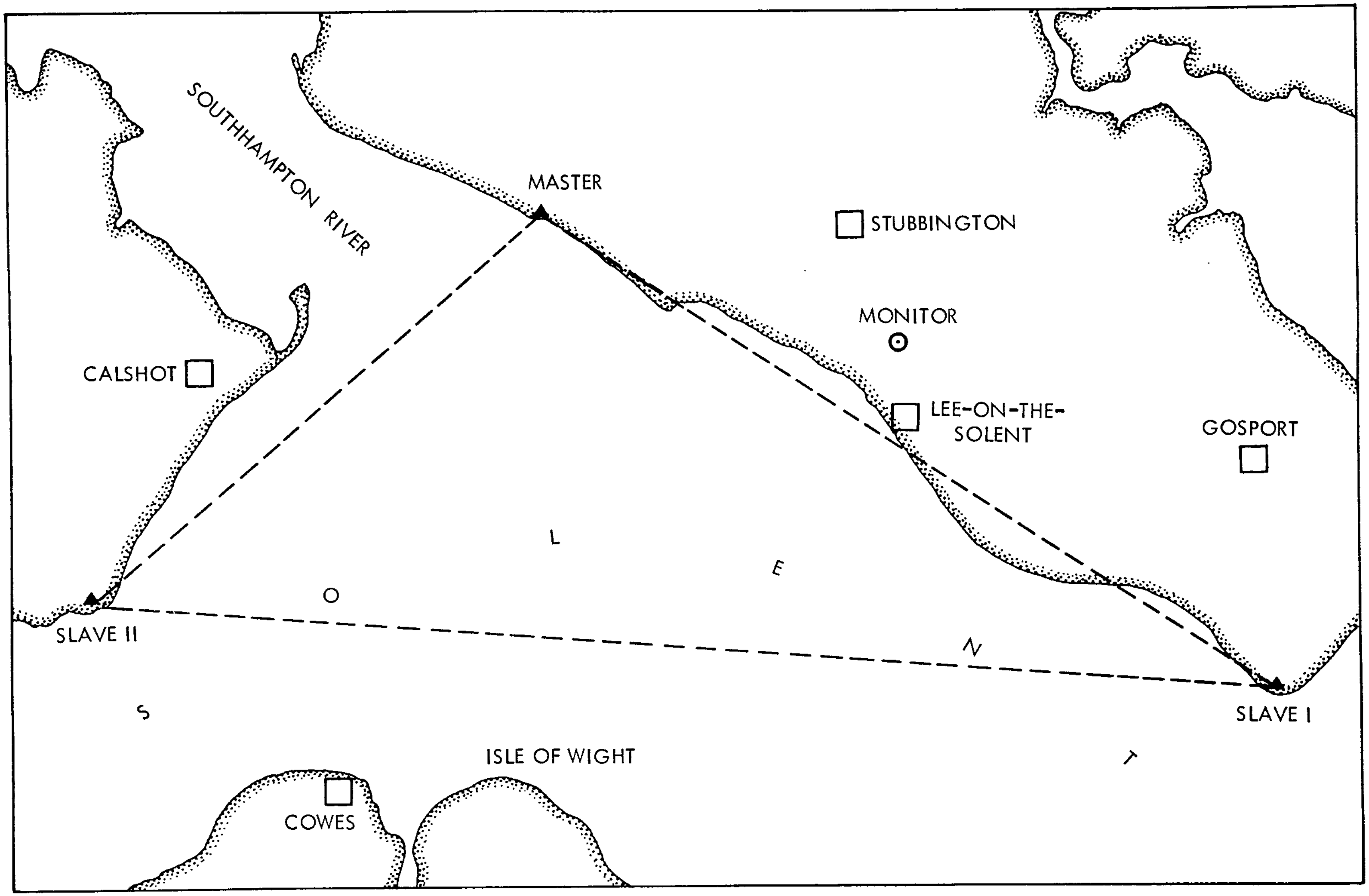

FIGURE 11. HOVERCRAFT SEA TRIAL AREA

CONCLUSIONS

The prime advantage that the sidewall hovercraft offers hydrographic surveying is speed. Days may be saved by being able to "catch a tide" and by expediting transit to or from survey areas.

The air cushion provides the hovercraft with a pneumatic damping system which is particularly advantageous when operating in choppy seas. Under such conditions, the hovercraft will provide a much smoother ride than conventional displacement craft and will be less affected by adverse sea conditions. The relative insensitivity of this craft to waves of smaller amplitude than the sidewall depth means that surveying may continue at 20 knots in seas up to four (4) feet. In rougher seas, surveying could still continue by operating the craft at lower speeds.

The hovercraft provides a stable easily controlled platform with adequate reserves of buoyancy. Fiberglass, used in the main structure is strong, resilient, and easily repaired in the event of damage. Furthermore, being non-magnetic and acoustically "transparent", it has distinct advantages for echo sounding applications.

Standard design diesel engines, used in both the lift and propulsion systems, eliminate the requirement for a large stockpile of spare parts.

Spacious cabin and deck spaces are provided on a near rectangular platform. Effective cabin and deck space as provided compares favorably to similar length displacement craft. Instruments may be deployed as required. Additional equipment or personnel may be readily carried up to design weight limits without loss of performance.

Although the craft discussed in this report measured up favorably to what is generally considered essential performance criteria, the search for high speed platforms will continue until the best possible platform/instrumentation interface is found.

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